NMC
Committed to Nuclear Excellence

Palisades Nuclear Plant
Operated by Nuclear Management Company, LLC

October 17, 2002

U S Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

10 CFR 50.90

NUCLEAR MANAGEMENT COMPANY, LLC
PALISADES NUCLEAR PLANT, DOCKET 50-255, LICENSE DPR-20
LICENSE AMENDMENT REQUEST: THERMAL MARGIN/LOW PRESSURE TRIP

Pursuant to 10 CFR 50.90, Nuclear Management Company, LLC (NMC) requests Nuclear Regulatory Commission (NRC) review and approval of a license amendment for the Palisades Nuclear Plant. NMC proposes to revise Table 3.3.1-2 of Appendix A, Technical Specifications (TS), by modifying a constant in the variable Thermal Margin/Low Pressure (TM/LP) trip equation. The proposed change would reduce calculated values for the variable TM/LP trip equation.

The proposed equation constant value change results from improvements in plant equipment used to establish the TM/LP trip setpoint. Ultrasonic feedwater flow measurement devices, recently installed at Palisades, result in less uncertainty applied in the methodology used for determining core power level. Additionally, the devices used to calculate the TM/LP trip setpoint have been replaced with devices having less uncertainty. These reduced uncertainties, when combined using the NRC endorsed methodology described in ANSI/ISA-S67.04-1994, "Setpoints for Nuclear Safety-Related Instrumentation," result in a reduction in the constant (bias term) used to calculate the variable TM/LP trip setpoint. NMC also conservatively assumed a higher rated thermal power to account for changes in the TM/LP trip function that would result from a future power uprate for the Palisades Nuclear Plant.

A001

Enclosure 1 provides a detailed description of the proposed change, background and technical analysis, No Significant Hazards Consideration Determination, and Environmental Review Consideration. Enclosure 2 provides the revised TS page reflecting the proposed change. Enclosure 3 provides the annotated TS page showing the changes proposed. Enclosure 4 provides the engineering analysis that documents the uncertainty for the TM/LP trip function. The proposed change is not expected to affect the TS Bases.

NMC requests approval of this proposed license amendment by April 17, 2003, to support timely implementation of the requested change. NMC further requests a 90-day implementation period following amendment approval.

A copy of this request has been provided to the designated representative of the State of Michigan.

SUMMARY OF COMMITMENTS

This letter contains no new commitments and no revisions to existing commitments.

I declare under penalty of perjury that the foregoing is true and accurate. Executed on October 17, 2002.

Douglas E. Cooper
Site Vice-President, Palisades

CC Administrator, Region III, USNRC
Project Manager, NRR, USNRC
NRC Resident Inspector - Palisades

Enclosures

ENCLOSURE 1

NUCLEAR MANAGEMENT COMPANY, LLC
PALISADES NUCLEAR PLANT
DOCKET 50-255

LICENSE AMENDMENT REQUEST PURSUANT TO 10 CFR 50.90:
THERMAL MARGIN/LOW PRESSURE TRIP

6 Pages Follow

PALISADES NUCLEAR PLANT
DOCKET 50-255

1.0 INTRODUCTION

Nuclear Management Company, LLC (NMC) requests to amend Operating License DPR-20 for the Palisades Nuclear Plant. NMC proposes to revise Table 3.3.1-2 of Appendix A, Technical Specifications (TS) by modifying a constant in the variable Thermal Margin/Low Pressure (TM/LP) trip equation. The proposed change would reduce calculated values for the variable TM/LP trip equation.

The proposed equation constant value change results from improvements in plant equipment used to establish the TM/LP trip setpoint. Ultrasonic feedwater flow measurement devices, recently installed at Palisades, result in less uncertainty applied in the methodology used for determining core power level. Additionally, the devices used to calculate the TM/LP trip setpoint have previously been replaced with devices having less uncertainty. These reduced uncertainties, when combined using the Nuclear Regulatory Commission (NRC) endorsed methodology described in ANSI/ISA-S67.04-1994, "Setpoints for Nuclear Safety-Related Instrumentation," result in a reduction in the constant (bias term) used to calculate the TM/LP trip setpoint. NMC also conservatively assumed a higher rated thermal power (RTP) value to account for changes in the TM/LP trip function that would result from a future power uprate for the Palisades Nuclear Plant.

2.0 DESCRIPTION OF THE PROPOSED AMENDMENT

NMC requests that the P_{var} equation in Table 3.3.1-2 (page 1 of 1) be changed from:

$$P_{var} = 2012(QA)(QR_1) + 17(T_{in}) - 9493$$

to:

$$P_{var} = 2012(QA)(QR_1) + 17(T_{in}) - 9559$$

Where:
P_{var} = variable primary coolant low-pressure trip setpoint, in psia
QA = axial shape function
QR_1 = radial peaking function
T_{in} = maximum primary coolant inlet temperature, in $^{\circ}F$
Constant = bias term (refer to Technical Analysis section)

3.0 BACKGROUND

The TM/LP trip function is part of the reactor protection system (RPS). The TM/LP trip is provided to prevent reactor operation when the departure from nucleate boiling ratio (DNBR) is insufficient. The TM/LP trip protects against slow reactivity or temperature increases and pressure decreases. The thermal margin monitors (TMM) provide the complex signal processing necessary to continuously calculate the TM/LP trip setpoint. The TM/LP setpoint (P_{var}) is based on Q power (the higher of power from the power range nuclear instruments, or ΔT power based on primary coolant system (PCS) hot and cold leg temperatures), maximum PCS cold leg temperature, and reactor core axial shape index.

Technical Specification Table 3.3.1-2 specifies the TM/LP trip setpoint using the P_{trip}, P_{min} and P_{var} equations. P_{trip} is defined as the larger of P_{min} and P_{var}. P_{min} is defined as a constant of 1750 psia. Analysis has shown that the uncertainty of the P_{var} equation can be reduced, allowing a decrease in calculated trip values, while maintaining the margin of safety provided by the TM/LP trip setpoint. Since the P_{var} equation is affected by RTP, NMC also conservatively assumed a higher RTP value to account for a future power uprate for Palisades Nuclear Plant.

4.0 TECHNICAL ANALYSIS

The change in TM/LP P_{var} equation results from two elements. The first element is a reduction in the overall TM/LP uncertainty based on combining the uncertainties from each of the TMM inputs with the TMM and other analysis uncertainties. The second element is an increase in the calculated P_{var} based on a planned future increase in RTP. The proposed change to the P_{var} equation constant takes both of these elements into consideration.

Lower TM/LP Uncertainty:

Engineering Analysis EA-ELEC08-0005, provided in Enclosure 4, documents the revised TM/LP uncertainty following the methodology of ANSI/ISA-S67.04-1994, which is endorsed by Regulatory Guide 1.105, "Setpoints for Safety-Related Instrumentation," revision 3. The uncertainty currently used is 165 psia, and the revised value would be 70 psia. This constitutes a 95 psia decrease in the P_{var} equation constant and a corresponding reduction in the value of P_{var}. The original uncertainty analysis used a conservative straight algebraic summation of individual errors to determine the final total uncertainty. The TM/LP setpoint uncertainty calculated by EA-ELEC08-005 maintains all necessary considerations in the development of uncertainties.

Planned Power Uprate:

NMC is considering a future 1.4% increase in RTP from 2530 Megawatts thermal (Mwt) to 2565.4 Mwt. To support this increase in RTP, an adjustment to the P_{var} equation is necessary. This additional adjustment was calculated by the following equations, using a value for the change in QR_1, which is based on the power uprate power level. The TM/LP trip function is modeled in the Final Safety Analysis Report (FSAR) Chapter 14 safety analysis with the QA term set to one (1), which maximizes the challenge to the TM/LP trip by maximizing the difference between the initial and trip pressures. Only QR_1 is a function of power. Therefore, the relative change in the QR_1 value (ΔQR_1) can be calculated as follows:

ΔQR_1 = (change in RTP) ÷ (current RTP)

= (2565.4 Mwt - 2530 Mwt) ÷ (2530 Mwt) = 0.014

The adjustment to the P_{var} equation to reflect the planned future 1.4% increase in RTP can be calculated using part of the equation from TS Table 3.3.1-2 as follows:

$2012(QA)(\Delta QR_1) = 2012(1)(0.014) = 28.17$ psia

In order to maintain the TM/LP trip setpoints assumed in the safety analyses, the constant of the TM/LP P_{var} equation would need to be altered such that a TM/LP trip would be initiated at a pressure that is higher than the current TS value. Therefore, the value of 28.17 psia is a positive adjustment to the negative constant in the P_{var} equation and this value can be conservatively rounded up to 29 psia. This element of the change to the TM/LP trip equation will, therefore, bound both the current and the planned future increase in RTP.

Revised Constant in Pvar Equation

The revised value of the constant in the P_{var} equation, taking into account the combined effect of the reduced uncertainty and power uprate, becomes:

current value + measurement uncertainty change + power uprate change = new constant

(-9493 psia) + (- 95 psia) + (+29 psia) = -9559 psia.

Substituting the new constant, the proposed P_{var} equation is therefore:

$$P_{var} = 2012(QA)(QR_1) + 17(T_{in}) - 9559$$

5.0 NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

Nuclear Management Company, LLC (NMC) has evaluated whether or not a significant hazards consideration is involved with the proposed amendment by focusing on the three standards set forth in 10 CFR 50.92, "Issuance of Amendment." The following evaluation supports the finding that operation of the facility in accordance with the proposed change would not:

1. <u>Involve a significant increase in the probability or consequences of an accident previously evaluated</u>.

The proposed amendment does not involve operation of any required structures, systems or components (SSCs) in a manner or configuration different from those previously recognized or evaluated. The methodology that was used in determining the recommended change in the constant follows Nuclear Regulatory Commission endorsed standard ANSI/ISI-S67.04-1994, "Setpoints for Nuclear Safety-Related Instrumentation." The probability of an accident previously evaluated will not be increased since the proposed change to the constant value in the Thermal Margin/Low Pressure (TM/LP) trip equation maintains all necessary considerations in the development of uncertainties.

The consequences of an accident previously evaluated will not be increased since the reactor is still protected from violating the TM/LP trip setpoint used in the safety analysis for Palisades Nuclear Plant.

Therefore, operation of the facility in accordance with the proposed change to the Technical Specifications would not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. Create the possibility of a new or different kind of accident from any accident previously evaluated.

The proposed change to the constant value for the TM/LP trip equation in the Technical Specifications would not change or add a system function. The proposed amendment does not involve operation of any required SSCs in a manner or configuration different from those previously recognized or evaluated. No new failure mechanisms will be introduced by the change being requested.

Therefore, this change does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. Involve a significant reduction in a margin of safety.

The proposed change to the constant value for the TM/LP trip equation in the Technical Specifications accounts for all uncertainties that affect the TM/LP trip setpoint. The revised TM/LP trip setpoint will continue to assure that the acceptance criteria established in the safety analysis will be met.

Therefore, this change does not involve a significant reduction in the margin of safety.

Based on the evaluation above, NMC has determined that the proposed change does not involve a significant hazards consideration.

6.0 ENVIRONMENTAL REVIEW CONSIDERATION

NMC has determined that the proposed amendment would not change requirements with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20. The proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluent that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

7.0 CONCLUSION

Based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public. The Palisades Plant Review Committee has reviewed this amendment request and has determined that the change involves no significant hazards consideration. The Palisades Offsite Safety Review Committee has concurred in this determination.

ENCLOSURE 2

NUCLEAR MANAGEMENT COMPANY, LLC
PALISADES NUCLEAR PLANT
DOCKET 50-255

LICENSE AMENDMENT REQUEST PURSUANT TO 10 CFR 50.90:
THERMAL MARGIN/LOW PRESSURE TRIP

REVISED TECHNICAL SPECIFICATION PAGE 3.3.1.8
AND
TECHNICAL SPECIFICATION PAGE CHANGE INSTRUCTIONS

2 Pages Follow

ATTACHMENT TO LICENSE AMENDMENT NO.

FACILITY OPERATING LICENSE NO. DPR-20

DOCKET NO. 50-255

Replace the following page of Appendix A, Technical Specifications with the attached revised page. The revised page is identified by amendment number and contains marginal lines indicating the areas of change.

REMOVE	INSERT
3.3.1.8	3.3.1.8

Table 3.3.1-2 (page 1 of 1)
Thermal Margin/Low Pressure Trip Function Allowable Value

The Allowable Value for the Thermal Margin/Low Pressure Trip, P_{trip}, is the higher of two values, P_{min} and P_{var}, both in psia:

$P_{min} = 1750$
$P_{var} = 2012(QA)(QR_1) + 17.0(T_{in}) - 9559$

Where:

$QA = -0.720(ASI) + 1.028;$	when $-0.628 \leq ASI < -0.100$
$QA = -0.333(ASI) + 1.067;$	when $-0.100 \leq ASI < +0.200$
$QA = +0.375(ASI) + 0.925;$	when $+0.200 \leq ASI \leq +0.565$
ASI = Measured ASI	when $Q \geq 0.0625$
ASI = 0.0	when $Q < 0.0625$
$QR_1 = 0.412(Q) + 0.588;$	when $Q \leq 1.0$
$QR_1 = Q;$	when $Q > 1.0$

Q = THERMAL POWER/RATED THERMAL POWER

T_{in} = Maximum primary coolant inlet temperature, in °F

ASI, T_{in}, and Q are the existing values as measured by the associated instrument channel.

ENCLOSURE 3

NUCLEAR MANAGEMENT COMPANY, LLC
PALISADES NUCLEAR PLANT
DOCKET 50-255

LICENSE AMENDMENT REQUEST PURSUANT TO 10 CFR 50.90:
THERMAL MARGIN/LOW PRESSURE TRIP

MARK-UP OF TECHNICAL SPECIFICATION PAGE 3.3.1.8
(Showing proposed change)
(additions are double underlined; deletions are strikethrough)

1 Page Follows

Table 3.3.1-2 (page 1 of 1)
Thermal Margin/Low Pressure Trip Function Allowable Value

The Allowable Value for the Thermal Margin/Low Pressure Trip, P_{trip}, is the higher of two values, P_{min} and P_{var}, both in psia:

$P_{min} = 1750$
$P_{var} = 2012(QA)(QR_1) + 17.0(T_{in}) - \cancel{9493}\underline{9559}$

Where:

$QA = -0.720(ASI) + 1.028;$	when $-0.628 \leq ASI < -0.100$
$QA = -0.333(ASI) + 1.067;$	when $-0.100 \leq ASI < +0.200$
$QA = +0.375(ASI) + 0.925;$	when $+0.200 \leq ASI \leq +0.565$
ASI = Measured ASI	when $Q \geq 0.0625$
ASI = 0.0	when $Q < 0.0625$
$QR_1 = 0.412(Q) + 0.588;$	when $Q \leq 1.0$
$QR_1 = Q;$	when $Q > 1.0$

Q = THERMAL POWER/RATED THERMAL POWER

T_{in} = Maximum primary coolant inlet temperature, in °F

ASI, T_{in}, and Q are the existing values as measured by the associated instrument channel.

ENCLOSURE 4

NUCLEAR MANAGEMENT COMPANY, LLC
PALISADES NUCLEAR PLANT
DOCKET 50-255

LICENSE AMENDMENT REQUEST PURSUANT TO 10 CFR 50.90: THERMAL MARGIN/LOW PRESSURE TRIP

Engineering Analysis EA-ELEC08-0005

34 Pages Follow

CONSUMERS
ENERGY

PALISADES NUCLEAR PLANT
ENGINEERING ANALYSIS COVER SHEET

EA- ELEC08-0005

Total Number of Sheets 34

Title Uncertainty Calculation for the Thermal Margin Low Pressure (TMLP) Trip Function Provided by Calculators PY-0102A, PY-0102B, PY-0102C and PY-0102D.

INITIATION AND REVIEW

Calculation Status		Preliminary ☐		Pending X			Final ☐		Superseded ☐	
Rev #	Description	Initiated		Init Appd By	Review Method			Technically Reviewed		Rev'r Appd By	Sup'v & S/DR Appd
		By	Date		Alt Calc	Detail Rev'w	Qual Test	By	Date		
0	Original Issue	RM Hamm	8/6/02	RMB 8-8-02		✓		DM Kennedy	8/8/02		RMB 8-8-02

1.0 OBJECTIVE / SCOPE

This calculation will compute the uncertainties associated with the Thermal Margin Monitor (TMM) and the associated Thermal Margin Low Pressure (TMLP) trip and alarm functions. The TMM is a digital based processing unit that continuously calculates the TMLP low pressure setpoint, based on primary coolant hot and cold leg temperature, and upper and lower power from the excore nuclear instrumentation. Uncertainties from each of the inputs will be combined with the TMM uncertainties and other analysis uncertainties to determine the worst case uncertainty for the TMLP trip setpoint. Uncertainties will be calculated for normal conditions only. Per Reference 9.1, seismic effects are not considered for these loops.

This calculation will address the following equipment:

PA - 0102AL, 0102BL, 0102CL, 0102DL

PY - 0102A, 0102B, 0102C, 0102D

I/I - 0013A, 0013B, 0013C, 0013D

Uncertainties are calculated for the following function:

- TMLP Reactor Trip Low Pressure Setpoint

{References 9.11, 9.12, 9.13}

2.0 FUNCTIONAL DESCRIPTION

The Thermal Margin Low Pressure trip protects the core from unacceptable DNBR situations caused by slow primary coolant system heat-up or slow depressurization events. The TMLP trip is initiated by a low primary system pressure which, based on power level and nuclear flux, is approaching a pressure too low to ensure adequate DNBR in all areas of the core. The TMM calculates a minimum primary system pressure based on 1.) Core Power calculated from the Primary Coolant System (PCS) hot and cold leg temperatures and 2.) Core Power from the excore nuclear instrumentation and 3.) the maximum loop cold leg temperature. The TMM selects the highest power level from the two sources to determine the low pressure setpoint. The final low pressure setpoint, Pvar, is calculated based on primary system cold leg temperature and the core axial flux distribution as measured by the upper and lower excore detectors. The minimum TMLP low pressure setpoint (Pmin) is fixed at 1750 PSIA. Thus the low pressure trip setpoint is the greater of the Pvar or Pmin value (auctioneered high).

This calculation documents the TMLP setpoint uncertainties for normal, non-harsh environments only. Per Reference 9.11, the Thermal Margin Low Pressure Trip (TMLP) function protects against slow power increase or depressurization events which will not cause the environmental conditions inside the containment to become harsh. Per Reference 9.11, other trip functions are provided to protect the NSSS during rapid power, flow, and pressure transients which could result in harsh environments.

The instrumentation addressed in this calculation calculates the TMLP setpoint and provides the following functions:

- Thermal Margin Low Pressure Reactor Trip

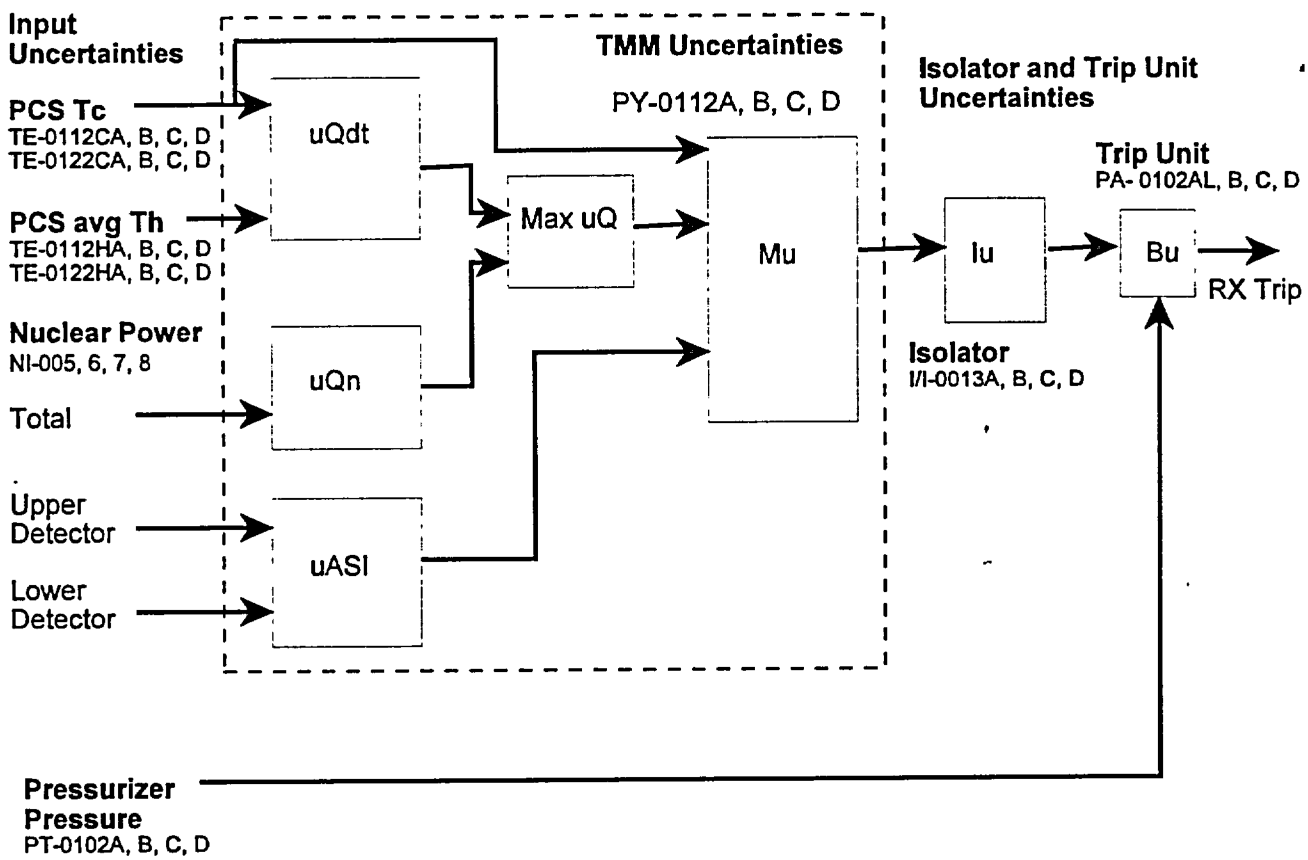
  The Thermal Margin Reactor Trip protects the core from slow temperature increases or depressurizations which could cause DNBR limits to be exceeded.

  The TMLP setpoint is calculated by the TMMs PY-0102A, 0102B, 0102C, and 0102D.

  This trip function is provided by the RPS Bistable Trip Units PA-0102AL, 0102BL, 0102CL, and 0102DL.

- Control Room TMLP Low Pressure Pre-Trip Alarm

  This alarm serves to warn the operator that Primary System Pressure is approaching the current calculated TMLP Low Pressure setpoint. This alarm is provided by PA-0102AL, 0102BL, 0102CL, and 0102DL. The TMLP Low Pressure Pre-Trip Alarm setpoint is not evaluated or developed by this calculation.



Functional Diagram: TMM & Thermal Margin Low Pressure Trip
(Developed using References 9.10& 9.11)

3.0 ANALYSIS INPUTS

3.1 TEMPERATURE INPUT CONSIDERATIONS

The temperature inputs to the TMM are provided by the PCS Narrow Range Temperature loops. The measurement uncertainty for both the PCS hot and cold leg temperatures is provided by Reference 9.2. The TMMs receive PCS temperature inputs from the following temperature loops:

TE-0112CA, CB, CC, CD	Cold Leg Temperature
TE-0122CA, CB, CC, CD	Cold Leg Temperature
TE-0112HA, HB, HC, HD	Hot Leg Temperature
TE-0122HA, HB, HC, HD	Hot Leg Temperature

3.1.1 Per Reference 9.2, the Total Loop Uncertainty (TLU) for a single cold leg temperature (Tc) input is ±1.00°F or ±1.00% Span for the 100°F span of the loop. The TMM monitors Tc from two opposite cold legs and selects the highest of the two for performing the setpoint determination. The high temperature select function limits the resultant uncertainty for the Tc input to a value less than that for a single measurement. To account for this decrease in uncertainty, the single measurement uncertainty will be adjusted using the single side distribution multiplier of 0.839 (see Sec. 13.8 of Ref. 9.1). This provides a conservative treatment of the measurement uncertainty as the rigorous analysis would result in a smaller multiplier and can be additionally justified based on the single sided low pressure function being considered in this calculation. Therefore, the uncertainty of the Tc input (uTc) term is:

$$uTc = \pm 1.0\ \%\ Span * 0.839 = \pm 0.839\ \%\ Span$$

3.1.2 Per Reference 9.2, the Total Loop Uncertainty for the average hot leg temperature average Th is ± 0.70°F or ± 0.70% Span for the 100°F span of the loop. Therefore, the Th input (uTh) term is:

$$uTh = \pm 0.70\ \%\ Span$$

3.1.3 The temperature input uncertainties of Reference 9.2 include all of the typical uncertainties (RA, MTE, Drift, etc.) required for consideration in the incoming measurement loop. Therefore, the only additional uncertainty term that needs to be considered, is the Setting Tolerance of the temperature inputs (Th & Tc) into the TMM. The temperature input Setting Tolerances (ThST & TcST) are found in Reference 9.7 to be:

DMM tolerance = ± 0.05 VDC over a 4VDC Span
ThST & TcST = ± 1.25 % Span

3.1.4 Per Reference 9.20, the total power calculated based on Delta-T is verified and calibrated as necessary against the daily heat balance calculation. The total power signal is calibrated to within ± 1.00 % Power if the difference is found to exceed ±1.00%. If the difference is equal to or greater than ± 2.00%, a condition report is written and an assessment of the error relative to the Safety Analysis is performed. A conservative bounding value of ± 2.00% can be established based on this correlation. Therefore the limit on the Delta-T power error is conservatively established as ± 2.00% Power, not including the Secondary Calorimetric error:

uDT = ± 2.00 % Power

3.2 NUCLEAR INSTRUMENTATION INPUT CONSIDERATIONS POWER RANGE EXCORE DETECTORS

The TMMs receive core power measurements from the Excore Nuclear Instrumentation Power Range channels. Three signals are provided by the NI system; Upper Chamber Flux (or power), Lower Chamber Flux and Total Power. The Total Power signal is the sum of the Upper and Lower Chamber values adjusted daily, based on the daily plant calorimetric power determinations.

The uncertainties associated with the NI inputs are documented in Reference 9.3.

The TMMs receive power inputs from the following channels:

NI-005
NI-006
NI-007
NI-008

3.2.1 Per Reference 9.3, the TLU for each of the Upper and Lower Chamber signals is ±1.13 % Chamber Power or ±0.90 % Chamber Span. Therefore, both the Upper and Lower Chamber power input (Nu & Nl) uncertainty terms are ±0.90 % Chamber Span.

uNu & eNl = ± 0.90 % Chamber Span

3.2.2 Per Reference 9.4, the individual NI channels are calibrated to a tolerance of ±1.00% Chamber Power or ±0.80 % Chamber Span for the 125% Chamber Power span of the power range NIs. Therefore, the Nuclear Setting Tolerance (NST) term is:

NST = ± 0.80 % Chamber Span

3.2.3 The power input uncertainties include all (RA, MTE, Drift, etc.) of the uncertainties required for consideration. Therefore, no additional input uncertainties are required to be combined with the values provided by Reference 9.3.

3.2.4 Per Reference 9.20, the total power output from the power range NI channels are verified and calibrated as necessary against the daily heat balance calculation. The total power signal is calibrated to within ±1.00 % Power if the difference is found to exceed ±1.00%. If the difference is equal to or greater than ±2.00%, a condition report is written and an assessment of the error relative to the Safety Analysis is performed. As the calculated uncertainty for the total NI power based on items 3.2.1 and 3.2.2 above will be less than the ±2.00% maximum difference, the ±2.00% maximum power difference will be used as the conservative bounding value for the uncertainty of the total NI power signal.

uNI = ± 2.00 % Power = % Total Reactor Power

3.3 PRESSURIZER PRESSURE (PCS PRESSURE) INPUT CONSIDERATIONS

The pressure input to the TMLP Trip Module is provided by the Pressurizer Pressure loops. The measurement uncertainty for the pressure input is provided by Reference 9.5. The TMLP Trip Module receives PCS pressure inputs from the following pressure loops:

PT-0102A, B, C, D

3.3.1 Per Reference 9.5, the Total Loop Uncertainty (TLU) for the PCS pressure input (P) is defined by the uncertainty at the output of the loop converter. Therefore, the uncertainty of the P input (uP) term is:

		Random	Positive Bias	Negative Bias
uP	=	± 1.98 % Span	+ 0.00 % Span (uPbp)	-0.10% Span (uPbn)

3.3.2 The pressure input uncertainties include all (RA, MTE, Drift, etc.) of the uncertainties required for consideration. Therefore, no additional input uncertainties are required to be combined with the values provided by Reference 9.5.

3.4 THERMAL MARGIN MONITOR

Per Reference 9.6, the TMLP setpoint is calculated by the Thermal Margin Monitor (TMM) which is a digital based unit provided by Gamma-Metrics. Reference 9.6 provides the primary design requirements for the TMM and performance specifications for various integral modules but does not provide an overall accuracy definition. A general product description document was identified which defines the overall performance specifications for the unit. As the overall performance specifications envelope all of the items defined within Reference 9.6, they will be used as the bounding performance numbers. A copy of the Gamma-Metrics document is included with this calculation as Attachment A.

3.4.1 The reference accuracy of the Gamma-Metrics Thermal Margin Monitor is identified in Attachment A. Therefore, the TMM Reference Accuracy (MRA) term is ±0.25 % Span.

MRA = ± 0.25 % Span

3.4.2 Per Reference 9.7, the TMM is calibrated as part of a string that includes a downstream signal isolator. Therefore, per Reference 9.1 the setting tolerance for the string is equal to the setting tolerance of the final device in the string. Therefore TMM Setting Tolerance (MST)is not applicable.

MST = N/A

3.4.3 Per Reference 9.7, the TMM is calibrated as part of a string that includes a downstream signal isolator. Therefore, per Reference 9.1 the MTE term for the string is equal to the MTE of the final device in the string. Therefore TMM MTE (MMTE) is not applicable.

MMTE = N/A

3.4.4 Per Attachment A, the TMM Temperature Effect (TEM) is specified as ±0.01 % / 1°C (1.8°F) change in temperature from calibration to normal operating temperature. Per Reference 9.7, the converter is located in the Control Room. Per Reference 9.1, a change in temperature of 15°F is used to calculate the TE for Control Room devices. Thus, TEM is calculated as follows:

TEM = ± (0.01 % Span/1.8°F)* 15°F
TEM = ± 0.08 % Span

3.4.5 Per Attachment A, the only drift term indicated is based on temperature which is accounted for in item 3.4.4 above. Based on review of the major modules that make up the TMM in Reference 9.6, all drift terms for the analog to digital devices were significantly smaller than the basic accuracy value used in item 3.4.1. Therefore, based on the performance data reviewed and the digital nature of the TMM, the TMM drift (MDR) is considered negligible.

MDR = N/A

3.4.6 Based on review of the major modules that make up the TMM in Reference 9.6, no performance variations based on supply power could be identified. Therefore, based on the performance data reviewed and the digital nature of the TMM, the TMM Power Supply Effect (MPSE) is considered negligible.

MPSE = N/A

3.4.7 Attachment A provides a Linearity accuracy value of ±0.1 %. Since it is identified separately, it will not be assumed to be part of the base accuracy of item 3.4.1, and the linearity value will be included in the overall uncertainty determination for the TMM. Therefore:

MLE = ±0.10 % Span

3.5 ISOLATOR CONSIDERATIONS (I/I-0013A, 0013B, 0013C, 0013D)

3.5.1 Per Reference 9.8, Isolator Reference Accuracy (IRA) is ± 0.100% Span. Thus:

IRA = ± 0.10 % Span

3.5.2 Per Reference 9.7, the isolator is the final device in a string calibration. Therefore, per Reference 9.1, the setting tolerance of the isolator (IST) is the setting tolerance for the string. Per Reference 9.7, the string has a setting tolerance of 10 PSI for the Pvar output. The span of the Pvar output is 1000 PSIA. Therefore:

IST = ± 10 PSI / 1000 PSIA * 100% Span
IST = ± 1.00% Span

3.5.3 Per Reference 9.7, a precision DMM (Data Precision 3500) is used to calibrate the final output of the TMM and isolator. Per Reference 9.25, the Data Precision 3500 has an accuracy of "± 0.007% of Rdg. + 0.001% FS + 1 digit." For a (max) reading of 5 volts, a Full Scale of 10 volts, and span of 4 volts, IMTE is:

IMTE = ± 0.01% Span

Per Reference 9.1, random uncertainty terms less than ±0.05% Span have a negligible impact on the uncertainty calculation and are not considered in the overall uncertainty determination. Therefore,

IMTE = N/A

3.5.4 Reference 9.8 does not specify a time dependent Drift value. When no drift value is specified by the equipment manufacturer, it is conservative to assume that time dependent drift for the calibration cycle is bounded by the Reference Accuracy value. Therefore isolator drift (IDR) is set equal to converter reference accuracy. Therefore:

IDR = IRA = ± 0.10% Span

3.5.5 Per Reference 9.8, isolator Temperature Effect (ITE) is specified as stability with a specification of better than 0.025% Span per °C (1.8 °F). Per Reference 9.21, the isolators are mounted on the Reactor Power Calibration and Indication Panel which is located in the control room. Per Reference 9.1, temperature variation from calibration to normal operation is assumed to be 15°F for devices located in the control room. Therefore ITE is determined as follows:

ITE = ± 0.025% Span / 1.8 °F * 15°F
ITE = ± 0.21% Span

3.6 BISTABLE CONSIDERATIONS (PA-0102AL, 0102BL, 0102CL, 0102DL)

3.6.1 Per Reference 9.14, the reference accuracy of the bistable is given as ±15mVdc throughout the full rated temperature range over a 30 day period. Per Reference 9.13, the Reactor Trip Units are calibrated every 92 days ± 25%. The Reference Accuracy uncertainty term will not be extrapolated over the Channel Functional Test interval because Reference Accuracy is typically not a time dependent term and bistable drift is accounted for in the drift term, BDR, below. Per Reference 9.14, these bistables have a voltage span of 4Vdc. Therefore, the Bistable Reference Accuracy (BRA) term is given as:

BRA = ± 0.015 Vdc / 4.0Vdc
BRA = ± 0.38 % Span

3.6.2 Per Reference 9.15, the bistable is calibrated to trip within ±1.0mVdc of the desired input voltage. Per Reference 9.15, these bistables have a voltage span of 4Vdc. Therefore, the Bistable Setting Tolerance term (BST) is given as:

BST = ± 0.001 / 4.0Vdc
BST = ± 0.03 % Span

Per Reference 9.1, random uncertainty terms less than ±0.05 % Span have a negligible impact on the uncertainty calculation and are not considered in the overall uncertainty determination. Therefore,

BST = N/A

3.6.3 Per Reference 9.1, the Measurement and Test equipment effect can be conservatively set to the setting tolerance of the device being calibrated. Therefore, the Bistable Measurement and Test Equipment Effect (BMTE) term is negligible.

BMTE = N/A

3.6.4 Per Reference 9.14, the bistable drift uncertainty term is given as ±3mVdc per 30 days (30 days ≅ 1 month). Per Reference 9.17, the time interval between calibrations is 92 days. To account for the 25% Technical Specification grace period, a time interval of 115 days (92 * 1.25) is used to calculate bistable drift. Per Reference 9.15, these Bistables have a voltage span of 4Vdc. Per Reference 9.1, the following equation is used to extrapolate the drift term:

$$BDR = \pm \frac{\sqrt{(0.003\ \text{Vdc})^2 (\frac{115\ \text{days}}{30\ \text{days}})}}{4\ \text{Vdc}}$$

$$BDR = \pm 0.15\ \%\ \text{Span}$$

3.6.5 Per Reference 9.14, a repeatability term of ±3mVdc is specified for the bistable. Per Reference 9.1, repeatability is typically included in the overall reference accuracy of a device. Per Reference 9.14, the overall reference accuracy of the bistable is given as ±15mVdc. Therefore, an additional repeatability term for the bistable is not included in the uncertainty calculation.

3.6.6 Per Reference 9.14, no uncertainty term is specified for the Bistable Temperature Effect (BTE). Per Reference 9.14, the design temperature range of the Bistable Trip Unit (BTU) is given as 40°F to 150°F, and the overall BTU accuracy is given as ±15 mVdc over the normal operating temperature range. Per Reference 9.7, the BTU is located in the Control Room and may experience a change in temperature of ±15°F from calibration to normal operation (Reference 9.1). Due to the small temperature change from calibration to normal operation, any temperature effect associated with the BTU is assumed to be negligible and is accounted for in the overall reference accuracy of the BTU. Therefore,

BTE = N/A

3.6.7 Per Reference 9.14, no Bistable Power Supply Effect (BPSE) is specified. Per Reference 9.1, safety related instrumentation is powered from Preferred A.C. Per Reference 9.1, the Preferred A.C. System provides 118Vac power which is regulated to ±3%. Therefore, since no Power supply Effect is specified and since the power to the Bistables is highly regulated, any Bistable Power Supply Effect (BPSE) is considered to be negligible and is accounted for in the overall reference accuracy of the BTU. Therefore,

BPSE = N/A

3.7 PROCESS MEASUREMENT EFFECT CONSIDERATIONS

3.7.1 Calorimetric Uncertainty

Both the Delta T and Nuclear Flux based core power measurements are calibrated based on the plant heat balance (calorimetric) performed either daily or during plant startup. Per Reference 9.16, the uncertainty of the plant calorimetric is ± 0.52 -0.03 % Power. The calorimetric uncertainty will be used as a Process Measurement Effect (QPME).

$$QPME = \pm 0.52 - 0.03 \text{ \% Power}$$

3.7.2 PCS Flow

As part of the original analysis (Ref. 9.9) of the TMLP setpoint, a PCS Flow uncertainty was assumed in the determination of the various power versus Delta T equation constants. The original analysis was performed prior to plant startup and assumed a PCS flow uncertainty as a conservative measure. Current safety analysis, as documented in Reference 9.11, considers the PCS flow uncertainty as part of the base analysis. Per References 9.11 and 9.22, the uncertainty assumed in the safety analysis bounds the calculated PCS Flow Uncertainty in Reference 9.22. Therefore, the PCS flow uncertainty no longer needs to be considered as part of the TMLP setpoint uncertainty.

3.7.3 NI System Power Range De-calibration

A de-calibration bias error is applied against the NI power range inputs when determining the Variable High Power Trip uncertainty (Ref. 9.18). The bias is only associated with the fast transient conditions for which the high power trip is credited. The TMLP trip is a slow transient based condition and therefore does not require the bias to be considered.

3.7.4 ASI Uncertainty

Uncertainty in the Axial Shape Index to reactor power is included in the basic transient analysis as documented by Reference 9.18. Any uncertainties related to the established ASI limits and the resulting limiting curves are considered enveloped by the analysis uncertainties. Therefore, the only additional ASI uncertainties that need to be considered as part of the TMLP setpoint uncertainty determination are those related to the in-plant measurement of ASI.

3.7.5 Th and Tc Temperature Stratification

Combustion Engineering supplied nuclear plants have documented numerous deviations in Th and Tc measurements due to stratification of fluid within the hot and cold leg piping. The temperature stratification issues of the Palisades plant have been fully evaluated and documented and shown to be significantly less that the original assumed values of Ref. 9.9. As discussed in Reference 9.11, Tc stratification does not exist for Palisades based on Tc measurements downstream of the primary coolant pumps. The Th temperature stratification error has been well defined and is calibrated out by the daily heat balance calculation of Reference 9.20. Therefore, no additional uncertainty needs to be included in the TMLP setpoint uncertainty for temperature stratification.

3.7.6 Curve Fit Error

A curve fit error relating to the linear approximations of the pressure versus power and Tc parameters was included in the original TMLP setpoint analysis of Reference 9.9. With the installation of the new TMM system, actual calculation of the non-linear equations is performed, thereby eliminating the need for linear approximation. Therefore, the error is no longer applicable.

4.0 ASSUMPTIONS

4.1 MAJOR ASSUMPTIONS

None

4.2 MINOR ASSUMPTIONS

4.2.1 Review of Reference 9.6 for other uncertainty terms that may be unique to the digital design of the TMM (scan rate, A:D resolution, etc.) did not identify any additional terms to be included within the TMM uncertainty determination. Any specific TMM uncertainties not addressed by this calculation are negligible when compared to the magnitude of the TMM uncertainties that have been considered and that the TMM uncertainties used are bounding values.

5.0 ANALYSIS

Note: Computations are performed to an accuracy of several significant digits, but presented in this calculation rounded to two decimal places in most cases. Hand verification of this calculation utilizing the rounded values may result in slightly different results due to round off errors.

The original uncertainty analysis for the TMLP setpoint of Reference 9.9 used a very conservative straight algebraic summation of individual errors to determine the final total uncertainty. Per Reference 9.1, uncertainties may be calculated by the statistical combination of independent random terms. The TMLP Total Setpoint Uncertainty (TSU) will be determined based on the statistical combination of terms.

The uncertainty will be determined by first determining the uncertainty of the two power inputs (Delta-T and NI) to establish the worst case power determination uncertainty. The power uncertainty will then be used to determine the uncertainty of the power peaking function on the setpoint determination. The uncertainties of the NI inputs (Upper and Lower) will be used to determine the uncertainty of the axial flux contribution to the setpoint determination. The flux uncertainties will then be combined with the Tc input uncertainty and the uncertainties of the TMM to determine the uncertainty of the calculated TMLP setpoint. The setpoint uncertainty will then be combined with uncertainties of the trip unit and the pressure input to determine a final TMLP trip uncertainty.

The basic power (Q) and PCS setpoint (Pvar) equations are defined by Reference 9.10 and 9.13.

$$Q = K\alpha * \Delta T + K\beta * \Delta T * Tc + K\gamma * \Delta T^2 + \tau * d/dt[\alpha * \Delta T + Tc] + \text{Bias}$$

This calculation will determine the worst case uncertainty for power under a steady state condition. The rate function, $\tau*d/dt[\alpha*\Delta T+Tc]$, has no effect on the uncertainty of the Pvar setpoint during steady state conditions. The resulting equation for B which will be used in this calculation is:

$$Q = K\alpha*\Delta T+K\beta*\Delta T*Tc+K\gamma*\Delta T^2+Bias$$

The other major equation (Pvar) and the required constants from Reference 9.13 are:

$$Pvar = \alpha*QA*QR_1+\beta*Tc+\beta*Kc*Tcal+\gamma \qquad (\gamma \text{ is a negative number})$$

Since Kc = 0, Tcal = Tc in all cases (Reference 9.11). Therefore, the Pvar equation is:

$$Pvar = \alpha*QA*QR_1+\beta*Tc+\gamma$$

QA = -0.720(ASI) + 1.028	when $-0.628 \le ASI < -0.100$
QA = -0.333(ASI) + 1.067	when $-0.100 \le ASI < +0.200$
QA = +0.375(ASI) + 0.925	when $+0.200 \le ASI \le +0.565$

ASI = Measured ASI	when $Q \ge 0.0625$
ASI = 0.0	when $Q < 0.0625$

QR1 = 0.412(Q) + 0.588	when $Q \le 1.0$
QR1 = Q	when $Q > 1.0$

Q = Thermal Power / Rated Thermal Power

Minimum value for Pvar = 1750 PSIA. Therefore, the Ptrip setpoint is the greater of the calculated Pvar value and the minimum setpoint of 1750 PSIA.

ASI is calculated based on the measured upper and lower channels of the NI power range detectors and is calculated as:

$$ASI = 2.177 * Y_E - 0.019 \qquad [9.23]$$
$$Y_E = (NI_{lower} - NI_{upper})/(NI_{lower}+NI_{upper})$$

The values indicated are for Channel A of the TMM. Each Channel has a specific set of conversion values based on actual Channel calibration. The Channel A values will be used in this calculation. The differences in the individual Channels will not affect the results of this calculation, as the results are based on deviations in the inputs and not the exact conversion values.

The values of the constants are:

$K\alpha = 4.31159e\text{-}03$ [9.19]
$K\beta = 3.15976e\text{-}05$ [9.19]
$K\gamma = 1.02728e\text{-}05$ [9.19]

$\alpha = 2{,}012$ [9.19]
$\beta = 17.0$ [9.19]
$\gamma = -9{,}493$ [9.19]

5.1 PROCESS MEASUREMENT EFFECT UNCERTAINTIES

5.1.1 The calorimetric uncertainty will affect the uncertainty of both the NI and Delta-T based power determinations. Therefore, the calorimetric PME must be included in both uncertainty determinations.

QPME = ± 0.52 -0.03 % Power [3.7.1]

5.2 UNCERTAINTIES IN POWER MEASUREMENT

The TMM uses the maximum power level input from the NI power and Delta-T power determinations to perform the low pressure setpoint calculation. As it is not possible to determine which source (Delta-T or Nuclear Power) the TMM will use at any time, the worst case power measurement uncertainty will be used as the power uncertainty into the TMM. Therefore the uncertainty associated with each power input must be determined. As the power uncertainty may vary over the power range, the power input uncertainty will be determined for the 100% power case as this will provide the more conservative value.

5.2.1 Delta-T Power Measurement Uncertainties

The Delta-T power determination uses the PCS Th and Tc temperatures along with the daily power calorimetric to establish core power. From Section 5.0, the basic equation for determining power based on Delta-T (ΔT)is:

$$Q = K\alpha * \Delta T + K\beta * \Delta T * Tc + K\gamma * \Delta T^2 + Bias$$

As the power versus ΔT equation is non-linear, the resulting error propagation is non-linear and must be calculated for specific levels of power (Ref.9.1). The error in power (Q) will be determined using a perturbation (partial derivative) technique to determine the change in Q for a known change in ΔT. Q is calculated to determine the worst case change in Q for the established maximum ΔT error. The equation used to compute ΔT power has an independent Tc term in addition to the ΔT term. However, because of the magnitude of the multipliers, the errors in Tc do not have a significant effect on the overall error in B. Additionally, the Tc and ΔT error terms work opposite to each other with an increasing Tc error decreasing the ΔT error. Therefore, the uncertainty associated with Q is conservatively based on ΔT errors only.

The error in ΔT is based on the individual uncertainties of the Th and Tc inputs and the Setting Tolerance for the inputs within the TMM where ΔT is calculated. Therefore:

uTh =	± 0.70 % Span	[3.1.2]
uTc =	± 0.84 % Span	[3.1.1]
ThST & TcST =	± 1.25 % Span	[3.1.3]

$$u\Delta T = \sqrt{uTh^2 + ThST^2 + uTc^2 + TcST^2}$$

$u\Delta T = \pm 2.08$ % Span (Th & Tc Span = 100°F)

$u\Delta T = \pm 2.08$ °F

As can be seen from the basic equation, the error in power will get larger as the basic power increases. Therefore, the maximum error will be determined based on 100% power. From Reference 9.19, nominal full power values are:

$\Delta T = 45.5\ °F$ [9.19]
$Tc = 532.5\ °F$ [9.19]
$Q = 100\%$ Power

$Q = K\alpha*\Delta T+K\beta*\Delta T*Tc+K\gamma*\Delta T^2+Bias$ (from above)

Therefore the error in Power (eQdt) for the error in ΔT (eΔT) indicated above was determined to be (see Attachment B for indication of partial results):

eQdt = 4.59 % Power

The total uncertainty of the Delta-T power measurement must also address the uncertainty of the calorimetric power determination used to calibrate the Delta-T power channels. Therefore, the final uncertainty in power calculated from Delta-T is:

QPME = ± 0.52 -0.03% Power [3.7.1]

$$uQdt = \sqrt{eQdt^2 + QPME^2} - QPMEb$$

uQdt = ± 4.62 -0.03 % Power
uQdt= +4.59 -4.65 % Power

The Delta-T power uncertainty effects the uncertainty of the QR1 variable of the Pvar equation. The QR1 uncertainty is maximized when power (Q) is greater than the rated full power. Power levels less than full power will reduce the QR1 variable and the resulting potential uncertainty. Therefore, only the full power level value will be considered.

The calculated Delta-T power uncertainty is larger than the 2.00% Nuclear Instrumentation total power uncertainty established in Section 3.2.4. It is also larger than the 2.00% maximum deviation allowed in the daily calorimetric performed by Reference 9.20 (Section 3.1.4). The actual uncertainty in measured power is limited by the daily calorimetric correction. While the uncertainty will typically be no greater than 1%, the worst case error of 2% (Per Section 3.1.4) will be used as the maximum measured power uncertainty. Since the measured power uncertainty is dependent on the daily calorimetric, the uncertainty of the calorimetric must be included in the measured power uncertainty.

Measured Power Uncertainty = uNI = 2.00 % Power [3.1.4]
QPME = ± 0.52 -0.03 % Power

$$uQ=\pm\sqrt{(\mathrm{uNI}^2+\mathrm{QPME}^2)}-QPMEb$$

uQ= ± 2.07 -0.03 % Power
uQ= + 2.04 -2.10 % Power

The power uncertainty in percent power effects the uncertainty of the TMLP setpoint (TMM output Pvar) depending on the nominal power level and the Axial Shape Index (ASI). By calculating the actual changes in Pvar for various nominal power levels and ASI values, a maximum Pvar error due to Delta-T power error can be determined. Calculating Pvar for various full power ASI values determined that the maximum error of concern was found to exist, at all power levels, when ASI is approximately -0.100. While an ASI value of less than -0.1 will give larger Pvar values, the ASI value is limited to a range of -0.08 to +0.4 at full power and above (Ref. 9.18). Reactor power less than full power provides additional margin in the DNBR and is therefore not the limiting case. Using the basic power and Pvar equations of Section 5.0, the effects of various uncertainties, Power and ASI values on the Pvar setpoint were evaluated. Refer to Attachment B for a printout of various Q and Pvar values calculated (Printout of electronic spreadsheet used to compare values). The maximum Pvar change (based on worst case ASI of -0.1), associated with the calculated power error (+2.04 -2.10 %), was found to be ± 46.49 PSI. Based on this, a maximum Pvar error of ± 50.00 PSI will be used as the maximum uncertainty attributable to variations in measured power. Therefore, the uncertainty of Q in terms of Pvar can be established as:

uQR1 = ± 50.00 PSI

5.2.2 Axial Shape Index Measurement Uncertainties

The Axial Shape Index (ASI) is measured by the Upper and Lower chambers of the power range NI system. Therefore, it is susceptible to errors due to the uncertainties of the Upper and Lower chamber measurements. Therefore, the total ASI measurement uncertainty is defined based on the uncertainties of the Upper and Lower detection chambers and the resulting calculation of YE and ASI within the TMM. Since Total Reactor Power is the sum of the Upper and Lower chamber measurements, the chamber power measurement represents only half of the total Reactor Power measurement and must be adjusted for the change in span. The basic uncertainties of the Upper and Lower chamber sections are:

Measurement Uncertainty (uNu & uNl)	= 0.90 % Chamber Span	[3.2.1]
Setting Tolerance (NST) (applicable to each)	= 0.80 % Chamber Span	[3.2.2]
Chamber Span	= 125% Chamber Power	[3.2.2]
Reactor Power (Upper + Lower)	= Chamber Power * 0.5	

$$uU = uL = \pm \sqrt{uNu^2 + NST^2}$$

uU = uL = ± 1.20 % Chamber Span
uU = uL = ± 0.75 % Reactor Pwr (% Rx Pwr = 1.25*Chamber Span*0.5)

Per Reference 9.10, the YE term is calculated from the Upper and Lower power measurements as:

$$Y_E = \frac{L - U}{L + U} = \frac{A}{B}$$

Where A and B are temporary variable names for the numerator and denominator of the YE equation.

Per Reference 9.23, the uncertainty propagation through a division equation can be calculated using the formula:

$$u = \pm \frac{K1}{K2} * \frac{[(B * u_A)^2 + (A * u_B)^2]^{0.5}}{B^2}$$

Where A & B are the numerator and denominator respectively and K1 and K2 are constants. For this case, K1 and K2 are not required and can be considered 1. A and B are numerator and denominator of the YE equation. With u_A and u_B the combined uncertainties of the Upper and Lower detection chambers (uU and uL) which makeup the numerator and denominator values.

$$uA = uB = \pm \sqrt{uU^2 + uL^2}$$

uA = uB = ± 1.06 % Reactor Pwr

The maximum value for A (L-U) is limited by the range of ASI values allowed at or near full power (Ref. 9.18) (as discussed in Section 5.2.1 above) and is:

ASI = -0.1 to +0.40.

The conversion between YE and ASI. Is:

ASI = 2.177 * YE - 0.019 [5.0]

YE = A/B ∴ A = YE*B

Using the above equations and the limits of ASI, a maximum value of 0.193 is calculated for YE. The B value (L+U) represents total reactor power. The uncertainty of ASI will be calculated at 100% total reactor power which establishes B at 100%.

Using the established values in the equation for uncertainty through a division function as defined above yields:

uYE = ± 0.011

Therefore, the uncertainty in YE can be converted to uncertainty in ASI as follows.

uASI = ± 2.177*uYE = ± 0.024

As with the power error, the impact of the ASI error is dependent on the nominal power level and the QA region (equation). By calculating actual Pvar variations for the established uASI for the different regions and various nominal ASI values, a worst case uASI to Pvar error can be determined. The worst case Pvar change was found in the upper ASI value region equal to or greater than +0.2. The change was approximately 18.11 PSI for the indicated uASI. Therefore, a value of 20 PSI will be used as the worst case ASI error.

uASI = ± 20.00 PSI

5.2.3 Combination and Conversion of Power and ASI Uncertainties

In order to combine the power and ASI uncertainties with the remaining loop uncertainties, they must be converted to a common unit. The uncertainties will be combined and converted to percent span of the Pvar signal. The remaining uncertainties for the TMM and trip unit can then be combined with the power and ASI uncertainties to determine a Total Loop Uncertainty.

Pvar Span = PCS Pressure Span = 1000 PSI [9.5]

$$uQR1QA = \pm \sqrt{uQR1^2 + uASI^2}$$

uQR1QA = ± 53.85 PSI
uQR1QA = ± 5.39 % Span (Pressure)

5.3 THERMAL MARGIN MONITOR & ISOLATOR UNCERTAINTIES (PY-0102A, 0102B, 0102C, 0102D & I/I-0013A, 0013B, 0013C, 0013D)

TMM Tag Number(s):	PY-0102A, 0102B, 0102C, 0102D	[9.6]
Manufacturer:	Gamma-Metrics	[9.6]
Model:	RCS-50	[9.6]

TMM Uncertainties:

Reference Accuracy (MRA)	: ± 0.25 % Span	[3.4.1]
Temperature Effect (TEM)	: ± 0.08 % Span	[3.4.4]
TMM Linearity (MLE)	: ± 0.10 % Span	[3.4.7]

Isolator Tag Numbers:	I/I-0013A, 0013B, 0013C, & 0013D	[9.21]
Manufacturer:	Action	[9.8]
Model No.:	AP4300 series	[9.8]

Isolator Uncertainties:

Reference Accuracy (IRA)	: ± 0.10 % Span	[3.5.1]
Setting Tolerance (IST)	: ± 1.00 % Span	[3.5.2]
Drift (IDR)	: ± 0.10 % Span	[3.5.4]
Temperature Effect (ITE)	: ± 0.21 % Span	[3.5.5]

Per Reference 9.1, the following equation is used to obtain the total uncertainties associated with the TMM : Isolator String:

$$Mu = \pm \sqrt{MRA^2 + TEM^2 + MLE^2 + IRA^2 + IST^2 + IDR^2 + ITE^2}$$

Mu = ± 1.07 % Span

To calculate the TMM output uncertainty, the TMM uncertainties must be combined with the uncertainties in the input signals used to determine the output (Pvar setpoint). The uncertainty of the power and flux distribution inputs was established in Section 5.2.3 (uQR1QA) and the uncertainties of the Tc input are defined in Section 3.1.

The total uncertainty in Tc is combination of the basic uncertainty and the Tc Setting Tolerance. The total Tc uncertainty must be converted to equivalent error in PSI by multiplying by the Beta factor which is 17 (Section 5.0).

$tuTc = \pm \sqrt{uTc^2 + TcST^2}$
tuTc = ± 1.51 % Span = ± 1.51°F
tuTc = ± 1.51 °F * 17 = 25.59 PSI

With a Pvar span of 1000 PSI, this yields:

tuTc = ± 2.56 % Span (pressure)

The total loop uncertainty through the TMM and Isolator is obtained utilizing the following equation:

$$Mo=\pm\sqrt{Mu^2+tuTc^2+uQR1QA^2}$$

Mo = ± 6.06% Span

5.4 TRIP UNIT UNCERTAINTIES (PA-0102AL, 0102BL, 0102CL, 0102DL)

Tag Number(s):	PA-0102AL, 0102BL, 0102CL, 0102DL	[9.15]
Manufacturer:	Combustion Engineering	[9.15]
Model:	47001-6	[9.15]

Trip Unit (Bistable) Uncertainties:

Reference Accuracy (BRA)	: ± 0.38 % Span	[3.6.1]
Drift (BDR)	: ± 0.15 % Span	[3.6.4]

Per Reference 9.1, the following equation is used to obtain the total uncertainties associated with the bistables:

$Bu = \pm \sqrt{BRA^2 + BDR^2}$
Bu = ± 0.41 % Span

The uncertainty out of the Trip Unit (Bo) is a combination of the uncertainty of the TMM output (Mo), the Trip Unit uncertainty (Bu) and the PCS pressure uncertainty (uP).

Pressure Uncertainty (uP) : ± 1.98 + 0.00 - 0.10 % Span [3.3.1]

The following equation is used to obtain the total uncertainties:

$$Bo = \pm\sqrt{Mo^2 + uP^2 + Bu^2} - uPb$$

	Random	Positive Bias	Negative Bias
Bo =	± 6.39 % Span	+0.00 % Span	-0.10 % Span

6.0 SETPOINT EVALUATION

6.1 THERMAL MARGIN LOW PRESSURE TRIP

Setpoint Evaluation

The TMLP setpoint is a variable setpoint calculated by the TMM and used by the TMLP Trip Bistable as the low PCS pressure trip setting. Therefore,

TLU = Bo

	Random	Positive Bias	Negative Bias
TLU =	± 6.39 % Span	+0.00 % Span	-0.10 % Span

Per Reference 9.5, the calibrated span of each loop is 1000 PSI. Therefore, the TLU, expressed in PSI, are as follows:

	Random	Positive Bias	Negative Bias
TLU =	± 63.86 PSI	+0.00 PSI	-1.00 PSI

	Total Positive Uncertainty	Total Negative Uncertainty
TLU =	+62.86 PSI	-64.86 PSI

Per Reference 9.11, the existing TMLP variable setpoint uncertainty is established as 165 PSI. The existing uncertainty was an initial worst case value calculated by CE (Ref. 9.9) prior to plant startup using many conservative assumptions. While acceptable, the uncertainty is overly conservative. Based on the results of this calculation, the following TMLP variable setpoint uncertainty should be used.

TMLP setpoint uncertainty = ± 70 PSI

This uncertainty provides an additional margin in excess of 5 PSI in addition to the margins added at various stages of the uncertainty determination.

6.2 THERMAL MARGIN LOW PRESSURE TRIP PRE-ALARM

Setpoint Evaluation

The TMLP Low Pressure Trip Pre-Alarm is a variable setpoint calculated by the TMM. The pre-trip setpoint is established as a fixed offset of the actual TMLP setpoint signal into the bistable. The TMLP trip pre-alarm will exhibit the same uncertainties as the TMLP trip setpoint.

7.0 SUMMARY OF RESULTS

TMLP Trip and Pre-Trip Alarm Uncertainties

Total loop uncertainties associated with the Thermal Margin Monitor and the TMLP trip functions are calculated in Section 5.4 of this calculation (Bo) and are expressed in terms of % Span and engineering units (PSI) as follows:

	Random	Positive Bias	Negative Bias
TMLP Trip =	± 6.39 % Span	+0.00 % Span	-0.10 % Span

	Total Positive Uncertainty	Total Negative Uncertainty
TMLP Trip =	+6.29 % Span	-6.49 % Span
TMLP Trip =	+62.86 PSI	-64.86 PSI

A total TMLP setpoint uncertainty of ± 70 PSI has been established as a bounding uncertainty for the TMLP setpoint.

8.0 CONCLUSION

The following functions have been addressed in this calculation:

Uncertainties have been calculated for the following functions:

- Thermal Margin Low Pressure Reactor Trip
- Thermal Margin Low Pressure Reactor Trip Pre-Alarm

See Section 7 of this calculation for results.

The results of this calculation show that the initial calculated TMLP uncertainties (established by Ref. 9.9) associated with the TMLP setpoint are larger than those determined by this calculation. Therefore, the TMLP uncertainty is overly conservative and can be reduced based on the more rigorous assessment contained in this calculation.

9.0 REFERENCES

9.1 EGAD-ELEC-08, Rev. 0, "Instrument Loop Uncertainty and Setpoint Methodology"

9.2 EA-ELEC08-97-07, Rev. 0, "Uncertainty Calculation for PCS Narrow Range Temperature Loops"

9.3 EA-ELEC08-97-08, Rev. 0. "Uncertainty Calculation for Dual Linear Power Range Nuclear Instrumentation Loops"

9.4 RI-62A, Rev. 3 (62B, 62C, 62D), "Power Range Safety Channel Alignment - Channel A",(B, C, D)

9.5 EA-ELEC08-97-02, Rev. 1, "Uncertainty Calculation Pressurizer Pressure Loops"

9.6 Vendor Manual for Gamma Metrics TMM, File No. J0054, Sheets 2 through 6, VTD No. 2364-0001 through 0005

9.7 RI-23A, Rev. 7 (23B, 23C, 23D), "Functional Testing of Thermal Margin Monitor - Channel A", (A, B, C)

9.8 Vendor Manual for Action Instruments Model AP4300/AP4310 Isolating Transmitters, File No. G086, Sheets 1370 and 1372

9.9 Combustion Engineering Transmittal P-CE-3561, September 10, 1971, to R. L. Haueter, Subject: Palisades Thermal Margin/Low Pressure Trip System

9.10 Drawing JL-130, Sheet 1, Rev. 3, "Logic For Thermal Margin Monitor"

9.11 ANF-90-078, Sept. 1990, Advanced Nuclear Fuels Corporation, "Palisades Cycle 9: Analysis of Standard Review Plan Chapter 15 Events"

9.12 UFSAR, "Updated Final Safety Analysis Report", Section 7.2, Revision 23

9.13 Technical Specifications, Section 3.3.1, Amendment 189

9.14 Vendor Manual, M-1Q, Sheet 998, Rev. 2, 4/16/96, "Palisades Plant Reactor Protective System Functional Description", VTD-0146-0032

9.15 Calibration Procedure MI-2, "Reactor Protective Trip Units", Revision 40

9.16 EA-ELEC08-01-01, Rev. 1, "Uncertainty Calculation Secondary Heat Balance"

9.17 Palisades Plant Technical Specifications, Chapter 3.3, "Instrumentation", Amendment 189, 208

9.18 EA-PPD-00-01, Rev. 1, "Palisades Cycle 16 Principal Plant Parameters"

9.19 EMF-95-033(P), Rev. 1, Siemens Analysis, "Palisades Thermal Margin Monitor Analysis", dated April 1995

9.20 DWO-1, Rev. 60, "Operator's Daily / Weekly Items, Mode 1, 2, 3 and 4"

9.21 Drawing VEN-M1-RD, Rev. C5, "Reactor Power Calibration and Indication Panel Assembly"

9.22 EA-ELEC08-97-06, Rev. 0, "Uncertainty Calculation for PCS Flow Loops"

9.23 QI-25, Rev. 2, "Thermal Margin Monitor Constants Checks"

9.24 ISA-RP67.04.02-2000, "Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation"

9.25 Procedure IS-B-69 /Checklist D, Revision 4, "Calibration Report"

ATTACHMENT A
Page 1 of 2
Gamma-Metrics Brochure

RCS-50 THERMAL MARGIN MONITOR

- MICROPROCESSOR-BASED SYSTEM ELIMINATES THE INACCURACY AND INFLEXIBILITY OF OLDER ANALOG SYSTEMS.
- PROVIDES THERMAL-MARGIN/LOW PRESSURE, VARIABLE HIGH POWER, AND EXCESSIVE AXIAL TILT TRIPS
- CRT AND KEYPAD COMBINE TO PROVIDE A SIMPLE AND FLEXIBLE OPERATOR INTERFACE
- DISPLAYS 24-HOUR OR 7-DAY TRENDS

THE RCS-50 THERMAL MARGIN MONITOR PROTECTS AGAINST FUEL FAILURE.

Gamma-Metrics RCS-50 Thermal Margin Monitor protects against reactor fuel failure caused by the loss of heat transfer capability between the fuel and coolant

It accomplishes this by computing the heat transfer conditions from reactor power temperature and pressure readings and providing alarms if a DNB condition is approached The stability and flexibility of the digital computation allow more efficient reactor operation than can be achieved with older analog thermal margin calculators

THE RCS-50 PROTECTS THE FUEL AT ALL POWER LEVELS.

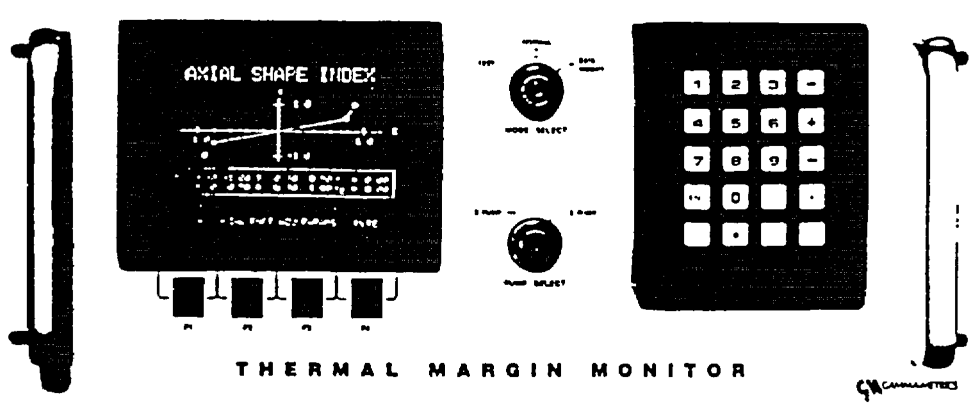
The RCS-50 computes reactor power from both thermal and neutron flux measurements It then selects the higher value for use in algorithms to provide alarms to protect the fuel at all power levels, yet without placing excessive restrictions on full-power operation

The RCS-50 measures reactor coolant temperature (inlet and outlet) neutron flux levels (upper and lower), and reactor pressure It computes thermal margin parameters for the reactor and provides alarm/trip signals for Thermal Margin Low Pressure, Axial Flux Tilt and Variable High Reactor Power It also provides analog outputs for average Neutron Flux Power Variance, and Minimum Allowable Reactor Pressure

THE RCS-50 IS COMPACT AND CLASS 1E.

The RCS-50 is a micro-computer that is qualified for use as class 1E safety-related equipment It includes digital and analog inputs and outputs CRT, removable keyboard, and mounts in a standard 19-inch instrument rack. A battery back-up protects the memory from a power failure, and serial communications ports allow data transmittal to other devices

All algorithms can be displayed on the CRT and are easily modified by authorized personnel via the keyboard and the keylock switch on the front panel The CRT can also display data trends from its data archive, as well as the results of the system's self test routines.

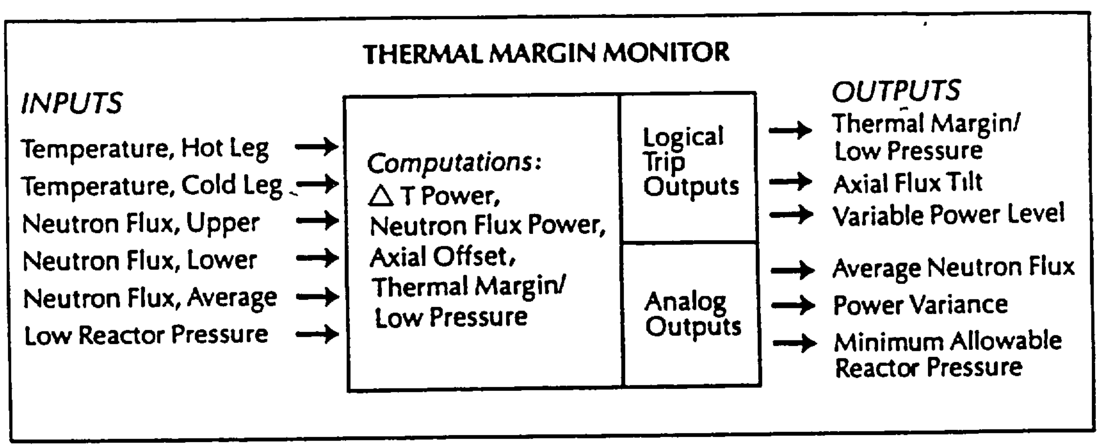


GAMMA-METRICS

ATTACHMENT A
Page 2 of 2

PERFORMANCE SPECIFICATIONS	Linearity[1] ±0.1%		Accuracy[2] ±0.25%	Response Time 100 ms		Drift 0.01%/°C
TRENDING	Parameters 10		1-Hour Average 24 Hours		4-Hour Average 7 Days	
MECHANICAL AND SERVICE SPECIFICATIONS	HEIGHT	WIDTH	DEPTH	WEIGHT	POWER ± 10%	SERVICE CONDITIONS
	8.75-in 22-cm	19-in 48-cm	16-in 41-cm	30-lb 14-Kg	117Vac 2A	0 to 60°C 10 to 95% RH

Seismic (SSE)—9g, 3 to 30 Hz



1. % of full scale
2. Output versus Input

Specifications subject to change without notice.

GAMMA-METRICS
5550 Oberlin Drive
San Diego, CA 92121
(619) 450-9811

10-50

Power and Pvar Perturbation Examples

	A	B	C	D	E	F	G	H	I	J
1	*Table 1 Constants*			*Table 2 Range of QA Values*					*Base Conditions*	
2	*Pvar Constants*				QA	*ASI values*	Pvar	Diff.	Tc base	532.5
3	*Alpha*		2012	QAI	1.48016	-0.628	N/A		DT base	46.447
4	*Beta*		17		1.316	-0.4	N/A		ASI base	0
5	*Gamma*		9493		1.10072	-0.101	N/A		Tc100	532.5
6					1.11728	-0.124	1807.467	34.16	DT100	45.5
7	*Power (Q) Constants*			QAm	1.1003	-0.1	1773.304			
8	K1		0.00431159		1.092308	-0.076	1757.224	-16.08	*QR1 for ASI Pvar*	
9	K2		3.15976E-05		1.000733	0.199	1572.975		*QR1 based on Q*	
10	K3		1.02728E-05		1.008392	0.176	1588.385	16.88	QR1	1
11	Bias		0.01699	QAlu	1	0.2	1571.500			
12					1.009	0.224	1589.608	-18.11	Power (Q)	100.00%
13	*ASI Constants*				1.075	0.4				
14	K1		2.177							
15	K2		0.0185							
16			*Pvar Values for Worst Case ASI & resulting QA Values*							
17		*eQ*	*Q per eDT*	*eTc*	*Q per eTc*	*eQ per eTc*	*-0.1*	*Diff. (new Pvar - base Pvar)*	*0.2*	*Diff. (new Pvar - base Pvar)*
18		5.00%	107.092%	7.00	103.119%	1.03%	1930.299	110.690	1714.184	100.600
19		3.00%	105.092%	6.00	102.972%	0.88%	1886.023	66.414	1673.944	60.360
20		2.50%	104.592%	5.00	102.825%	0.73%	1874.954	55.345	1663.884	50.300
21		2.10%	104.192%	4.00	102.679%	0.59%	1866.098	46.490	1655.836	42.252
22		2.04%	104.132%	3.00	102.532%	0.44%	1864.770	45.162	1654.629	41.045
23		2.00%	104.092%	2.00	102.385%	0.29%	1863.885	44.276	1653.824	40.240
24		1.00%	103.092%	1.00	102.238%	0.15%	1841.747	22.138	1633.704	20.120
25										
26	*Q base*		102.092%				1819.609		1613.584	
27										
28		-1.00%	101.092%	-1.00	101.945%	-0.15%	1797.471	-22.138	1580.549	-33.035
29		-2.00%	100.092%	-2.00	101.798%	-0.29%	1775.333	-44.276	1572.260	-41.324
30		-2.04%	100.052%	-3.00	101.651%	-0.44%	1774.447	-45.162	1571.928	-41.656
31		-2.10%	99.992%	-4.00	101.505%	-0.59%	1773.119	-46.490	1571.431	-42.153
32		-2.50%	99.592%	-5.00	101.358%	-0.73%	1764.264	-55.345	1568.115	-45.469
33		-3.00%	99.092%	-6.00	101.211%	-0.88%	1753.194	-66.414	1563.970	-49.614
34		-5.00%	97.092%	-7.00	101.064%	-1.03%	1708.918	-110.690	1547.391	-66.193
35										
36				*uDT*	*Q per uDT*	*uQdt*				
37				2.08	104.592%	4.59%				
38				-2.08	95.418%	-4.58%				
39										
40	*The Base conditions were established such that an indicated 100% power condition would exist for the maximum negative uncertainty. The resulting actual power condition was then used as the base line for determining the effect of variations on the calculat*									
41										
42	*The Tc100 and DT100 conditions represent the design values for 100% Power and were used to determine the affect of DT error (uDT and uQdt).*									

Attachment B

Power and Pvar Perturbation Examples

	A	B	C	D	E	F	G	H	I	J
1	Table 1	Constants		Table 2	Range of QA Values				Base Conditions	
2	Pvar Constants				QA	ASI values	Pvar	Diff	Tc base	532 5
3	Alpha		2012	QAI	=-0 72*$F3+1 028	-0 628	N/A		DT base	46 447
4	Beta		17		=-0 72*$F4+1 028	-0 4	N/A		ASI base	0
5	Gamma		9493		=-0 72*$F5+1 028	-0 101	N/A		Tc100	532 5
6					=-0 72*$F6+1 028	-0 124	=$C$3*$E6*$J$10+$C$4*$J$	=G6-G7	DT100	45 5
7	Power (Q) Constants			QAm	=-0 333*$F7+1 067	-0 1	=$C$3*$E7*$J$10+$C$4*$J$			
8	K1		0 00431159		=-0 333*$F8+1 067	-0 076	=$C$3*$E8*$J$10+$C$4*$J$	=G8-G7	QR1 for ASI Pvar	
9	K2		0 0000315976		=-0 333*$F9+1 067	0 199	=$C$3*$E9*$J$10+$C$4*$J$		QR1 based on Q	
10	K3		0 0000102728		=-0 333*$F10+1 067	0 176	=$C$3*$E10*$J$10+$C$4*$J	=G10-G11	QR1	=IF($J$12>1,$J$12,+0 41
11	Bias		0 01699	QAlu	=0 375*$F11+0 925	0 2	=$C$3*$E11*$J$10+$C$4*$J			
12					=0 375*$F12+0 925	0 224	=$C$3*$E12*$J$10+$C$4*$J	=G11-G12	Power (Q)	1
13	ASI Constants				=0 375*$F13+0 925	0 4				
14	K1		2.177							
15	K2		0 0185							
16							for Worst Case ASI & resulting			
17		eQ	Q per eDT	eTc	Q per eTc	eQ per eTc	=F7	Diff (new Pvar - base Pvar)	=F11	Diff (new Pvar - base Pvar)
18		0 05	=$C$26+$B18	7	=$C$8*$J$3+$C$9*$J$3*($J	=E18-$C$26	=$C$3*$E$7*($C18)+$C$4*$	=G18-$G$26	=$C$3*$E$11*($C18)+$C	=I18-$I$26
19		0 03	=$C$26+$B19	6	=$C$8*$J$3+$C$9*$J$3*($J	=E19-$C$26	=$C$3*$E$7*($C19)+$C$4*$	=G19-$G$26	=$C$3*$E$11*($C19)+$C	=I19-$I$26
20		0 025	=$C$26+$B20	5	=$C$8*$J$3+$C$9*$J$3*($J	=E20-$C$26	=$C$3*$E$7*($C20)+$C$4*$	=G20-$G$26	=$C$3*$E$11*($C20)+$C	=I20-$I$26
21		0 0209	=$C$26+$B21	4	=$C$8*$J$3+$C$9*$J$3*($J	=E21-$C$26	=$C$3*$E$7*($C21)+$C$4*$	=G21-$G$26	=$C$3*$E$11*($C21)+$C	=I21-$I$26
22		0 0206	=$C$26+$B22	3	=$C$8*$J$3+$C$9*$J$3*($J	=E22-$C$26	=$C$3*$E$7*($C22)+$C$4*$	=G22-$G$26	=$C$3*$E$11*($C22)+$C	=I22-$I$26
23		0 02	=$C$26+$B23	2	=$C$8*$J$3+$C$9*$J$3*($J	=E23-$C$26	=$C$3*$E$7*($C23)+$C$4*$	=G23-$G$26	=$C$3*$E$11*($C23)+$C	=I23-$I$26
24		0 01	=$C$26+$B24	1	=$C$8*$J$3+$C$9*$J$3*($J	=E24-$C$26	=$C$3*$E$7*($C24)+$C$4*$	=G24-$G$26	=$C$3*$E$11*($C24)+$C	=I24-$I$26
25										
26	Q base		=$C$8*$J$3+$C$9*$J$3*$J$2+$C				=$C$3*$E$7*($C26)+$C$4*$		=$C$3*$E$11*($C26)+$C	
27										
28		-0 01	=$C$26+$B28	-1	=$C$8*$J$3+$C$9*$J$3*($J	=E28-$C$26	=$C$3*$E$7*($C28)+$C$4*$	=G28-$G$26	=$C$3*$E$11*(0 412*$C2	=I28-$I$26
29		-0 02	=$C$26+$B29	-2	=$C$8*$J$3+$C$9*$J$3*($J	=E29-$C$26	=$C$3*$E$7*($C29)+$C$4*$	=G29-$G$26	=$C$3*$E$11*(0 412*$C2	=I29-$I$26
30		-0 0206	=$C$26+$B30	-3	=$C$8*$J$3+$C$9*$J$3*($J	=E30-$C$26	=$C$3*$E$7*($C30)+$C$4*$	=G30-$G$26	=$C$3*$E$11*(0 412*$C3	=I30-$I$26
31		-0 0209	=$C$26+$B31	-4	=$C$8*$J$3+$C$9*$J$3*($J	=E31-$C$26	=$C$3*$E$7*($C31)+$C$4*$	=G31-$G$26	=$C$3*$E$11*(0 412*$C3	=I31-$I$26
32		-0 025	=$C$26+$B32	-5	=$C$8*$J$3+$C$9*$J$3*($J	=E32-$C$26	=$C$3*$E$7*($C32)+$C$4*$	=G32-$G$26	=$C$3*$E$11*(0 412*$C3	=I32-$I$26
33		-0 03	=$C$26+$B33	-6	=$C$8*$J$3+$C$9*$J$3*($J	=E33-$C$26	=$C$3*$E$7*($C33)+$C$4*$	=G33-$G$26	=$C$3*$E$11*(0 412*$C3	=I33-$I$26
34		-0 05	=$C$26+$B34	-7	=$C$8*$J$3+$C$9*$J$3*($J	=E34-$C$26	=$C$3*$E$7*($C34)+$C$4*$	=G34-$G$26	=$C$3*$E$11*(0 412*$C3	=I34-$I$26
35										
36				uDT	Q per uDT	uQdt				
37				2 0782	=$C$8*($J$6+$D$37)+($C$9	=E37-1				
38				-2 0782	=$C$8*($J$6+$D$38)+($C$9	=E38-1				
39										
40	The Base conditions were established such that an indicated 100% power condition would exist for the maximum negative uncertainty The resulting actual power condition was then used as the base line for determining the effect of variations on the calculat									
41										
42	The Tc100 and DT100 conditions represent the design values for 100% Power and were used to determine the affect of DT error (uDT and uQdt)									